

INDEPENDENT INTELLIGENT LIMIT SWITCH

Background of the Invention

[0001] Conventional limit switch implementations are generally categorized as: 1) a dependent-embedded system or 2) an independent physical system. The dependent-embedded design utilizes position feedback data from the feedback element within the instrument to provide a virtual limit switch. The main disadvantage of this embedded implementation is that the "switch" is not isolated or independent from the operation of the instrument and is wholly dependent on the instrument's operation. These types of limit switches cannot be used for an interlock application.

[0002] The independent physical limit switch solves the isolation issue associated with the embedded design, but since it is not integrated within the microprocessor-based instrument, the instrument's calibration and limit switch trip point set are not coupled. The complete and "un-intelligent" aspect of the independent, physical switches requires resetting the trip point each time the instrument is recalibrated. Additionally, the setup of the limit switches is typically blind and requires taking the valve out of operation to specifically stroke the valve to establish the trip points. Some manufacturers utilize both implementations, but still do not solve the aforementioned disadvantages.

Brief Description of the Drawings

[0003] Figure 1 is a block diagram of a digital valve positioning system in accordance with the present invention; and

[0004] Figure 2 is a block diagram of an independent intelligent limit switch, as used with the positioning system of Figure 1.

Detailed Description of a Preferred Embodiment

[0005] While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and will herein be described in detail, a preferred embodiment of the invention with the understanding

that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspects of the invention to the embodiment illustrated.

[0006] This invention incorporates a low-cost dedicated microprocessor to physical limit switches to provide an independent, intelligent limit switch assembly. The limit switch embedded controller can communicate to the instrument microprocessor to establish trip points, but still provide isolated operation appropriate for interlock operation.

[0007] A digital valve positioning system, generally designated 10, is illustrated in Figures 1 and 2. The system 10 comprises a valve 12 and a valve controller 14. The valve controller 14 has a controller microprocessor 16 and a controller memory 18. As is well known, the controller microprocessor 16 controls the position of the valve 12 by issuing commands to a current to pressure (I/P) converter 19 via a digital to analog (D/A) converter 19a.

[0008] The system 10 further includes a valve actuator 20 having an output 20a coupled to the valve 12 to control the position of the valve 12 over a range of motion in response to an output from the valve controller 14. A first position sensor 24, such as a conventional Hall effect sensor, determines the position of the valve 12.

[0009] As is well known, the controller memory stores calibration data defining the range of motion of the valve 12.

[0010] In accordance with the invention, the system 10 further includes an intelligent limit switch 30 for generating a limit switch state signal indicative of a state of the valve 12 being above or below a threshold set point.

[0011] The limit switch 30 utilizes an operators interface 32 communicatively coupled to the controller microprocessor 16 for entering limit switch set point data defining the location of the threshold set point into the controller memory 18. The operators interface 32 includes a display 33, such as an LCD display 34 and an LCD control/driver 34, which can be used to indicate the state of the limit

switch 30. The operators interface 32 also includes a pushbutton interface 35. In the present embodiment, the limit switch 30 utilizes the same operators interface 30 as is used to perform conventional communication with the controller microprocessor 16, such as to enter the calibration data.

[0012] The limit switch 30 further includes a second position sensor 36, also such as a Hall effect sensor, and a limit switch memory 38. The second position sensor 36 generates an output signal indicative of the position of the valve 12. The limit switch memory 38 is communicatively coupled to a limit switch microprocessor 40.

[0013] A communication link 44 including a first optical isolation unit 45 provides isolated communication between the controller microprocessor 16 and the limit switch microprocessor 40 for transferring the limit switch set point data from the controller memory 18 to the limit switch memory 38.

[0014] The limit switch microprocessor 40 includes a first limit switch microprocessor output 40a. The limit switch microprocessor 40 is responsive to the second position sensor output signal and the limit switch set point data stored in the limit switch memory 38 to generate the state signal at the first limit switch microprocessor output 40a.

[0015] A first limit switch output 46 is communicatively coupled to the first limit switch microprocessor output 40a for generating a first limit switch output signal indicating the state of the limit switch. The first output signal is preferably a current control signal, such as a 1-4 mA signal.

[0016] The limit switch 30 also provides a second output, permitting the limit switch 30 to function as two limit switches. Specifically, the operators interface 32 is communicatively coupled to the controller microprocessor 16 for entering, into the controller memory 18, second limit switch data defining the location of a second threshold set point.

[0017] The isolated communication link 44 transfers the second limit switch set point data from the controller memory 18 to the limit switch memory 38. The limit switch microprocessor 40 includes a second limit

switch microprocessor output 40b. The limit switch microprocessor 40 is responsive to the second position sensor output signal and the second limit switch set point data stored in the limit switch memory 38 to generate a second state signal, indicative of a second state of the valve 12 being above or below the second threshold set point, at the second limit switch microprocessor output.

[0018] The limit switch 30 includes a second output 49 coupled to the limit switch microprocessor second output for generating a second output signal indicating the secondary state of the limit switch. The second output signal is a current control signal, such as a 1-4 mA signal.

[0019] A second optical isolation unit 50 optically isolates the second limit switch from the first limit switch.

[0020] The limit switch data defines the location of the threshold set point as a percentage of the range of motion. Thus if the valve fails, or otherwise must be replaced, it need only be recalibrated. The limit switch set point data does not need to be changed and the limit switch calibration data is automatically adjusted through the communication link 44 as part of the valve calibration process.

[0021] The limit switch 30 is powered by the current control signal, which is independent of the controller power to the valve control. Thus failure of the controller power will not affect the operation of the limit switch 30.

[0022] The limit switch 30 operates independent of the valve controller 14. Thus failure of the valve controller 14 will not affect the operation of the limit switch 30.

[0023] The system 10 includes a connector 54 for communicatively coupling the controller microprocessor 16 to a network 55 via a conventional communications interface 56. This permits analog and/or digital communication with other devices on the network 55, such as a process controller 60.

[0024] The present invention has been described with respect to a certain embodiment, which is not meant to limit the invention. Those skilled in the art will understand that variations from the embodiment described

herein may be made without departing from the invention as set forth in the appended claims.